

Extremity Sprains/Strains

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Introduction

Musculoskeletal injuries in the U.S. space program are relatively common and occur secondary to intensive crew training and in-flight activities. Possible mechanisms of in-flight injury include handling high-mass objects during transfer operations and Extravehicular Activities (EVAs), high speed translation during busy activities, and the use of the on-board exercise hardware during regular exercise sessions. In microgravity, there is greater risk for an upper extremity injury than a lower extremity injury.^{[1][2]}

A history of pre-flight injury or joint surgery places a crewmember at up to three times higher risk for injuries during flight. Pre-flight injuries most commonly involve ankle, knee, and shoulder injuries attributed to high training intensity or sports. In-flight injuries (including ligamentous strains, sprains, and musculoskeletal overuse) have generally been mild. Crew Medical Officers (CMOs) are trained to perform adequate orthopedic evaluations which can be helpful in establishing the correct diagnosis and treatment plan. The only imaging modality currently available on orbit is sonography. Appropriate splinting and analgesics are available on board.^[2]

Clinical Priority and Clinical Priority Rationale by Design Reference Mission

One of the inherent properties of space flight is a limitation in available mass, power, and volume within the space craft. These limitations mandate prioritization of what medical equipment and consumables are manifested for the flight, and which medical conditions would be addressed. Therefore, clinical priorities have been assigned to describe which medical conditions will be allocated resources for diagnosis and treatment. “Shall” conditions are those for which diagnostic and treatment capability must be provided, due to a high likelihood of their occurrence and severe consequence if the condition were to occur and no treatment was available. “Should” conditions are those for which diagnostic and treatment capability should be provided if mass/power/volume limitations allow. Conditions were designated as “Not Addressed” if no specific diagnostic and/or treatment capability are expected to be manifested, either due to a very low likelihood of occurrence or other limitations (for example, in medical training, hardware, or consumables) that would preclude treatment. Design Reference Missions (DRMs) are proposed future missions designated by a set of assumptions that encompass parameters such as destination,

length of mission, number of crewmembers, number of Extravehicular Activities (EVAs), and anticipated level of care. The clinical priorities for all medical conditions on the Exploration Medical Condition List (EMCL) can be found here (https://humanresearchwiki.jsc.nasa.gov/index.php?title=Category:All_DRM). The EMCL document may be accessed here (https://humanresearchwiki.jsc.nasa.gov/images/6/62/EMCL_RevC_2013.pdf).

Design Reference Mission	Clinical Priority	Clinical Priority Rationale
<p>Lunar sortie mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> 4 crewmembers (3 males, 1 female) 14 days total 4 EVAs/ crewmember <u>Level of Care 3</u> 	Shall	Sprains, strains, and overuse injuries during space flight may potentially occur secondary to EVAs, vigorous exercise in flight or secondary to in-flight maintenance tasks. Therefore, diagnostic and treatment capability shall be manifested.
<p>Lunar outpost mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> 4 crewmembers (3 males, 1 female) 180 days total 90 EVAs/ crewmember <u>Level of Care 4</u> 	Shall	Sprains, strains, and overuse injuries during space flight may potentially occur secondary to EVAs, vigorous exercise in flight or secondary to in-flight maintenance tasks. Therefore, diagnostic and treatment capability shall be manifested.
<p>Near-Earth Asteroid (NEA) mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> 3 crewmembers (2 males, 1 female) 395 days total 30 EVAs/ crewmember <u>Level of Care 5</u> 	Shall	Sprains, strains, and overuse injuries during space flight may potentially occur secondary to EVAs, vigorous exercise in flight or secondary to in-flight maintenance tasks. Therefore, diagnostic and treatment capability shall be manifested

Initial Treatment Steps During Space Flight

A link is provided to a prior version of the International Space Station (ISS) Medical Checklist, which outlines the initial diagnostic and treatment steps recommended during space flight for various conditions which may be encountered onboard the ISS. Further diagnostic and treatment procedures beyond the initial steps outlined in the

Medical Checklist are then recommended by the ground-based Flight Surgeon, depending on the clinical scenario. Please note that this version does not represent current diagnostic or treatment capabilities available on the ISS. While more recent versions of this document are not accessible to the general public, the provided version of the checklist can still provide a general sense of how medical conditions are handled in the space flight environment. Medical Checklists will be developed for exploration missions at a later point in time.

Please note this file is over 20 megabytes (MB) in size, and may take a few minutes to fully download.

ISS Medical Checklist (http://www.nasa.gov/centers/johnson/pdf/163533main_ISS_Med_CL.pdf)

Capabilities Needed for Diagnosis

The following is a hypothetical list of capabilities that would be helpful in diagnosis. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.

- Imaging [such as ultrasound, X-ray, Computed Tomography (CT), Magnetic Resonance Imaging (MRI)]

Capabilities Needed for Treatment

The following is a hypothetical list of capabilities that would be helpful in treatment. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.

- Immobilization with Structural Aluminum Malleable (SAM®) splint
- All Cotton Elastic (ACE™) wrap
- Analgesics (non-narcotic and narcotic, oral, and injectable)
- Cold pack
- Hot pack
- Non-sterile gloves
- Medication delivery device (such as Carpuject injector)
- Skin cleanser [such as alcohol/ Benzalkonium antiseptic (BZK)/iodine]
- Band-Aid

Associated Gap Reports

The NASA Human Research Program (HRP) identifies gaps in knowledge about the health risks associated with human space travel and the ability to mitigate such risks. The overall objective is to identify gaps critical to human space missions and close them through research and development. The gap reports that are applicable to this

medical condition are listed below. A link to all of the [HRP gaps](http://humanresearchroadmap.nasa.gov/Gaps/) can be found here (<http://humanresearchroadmap.nasa.gov/Gaps/>).

- 2.01 - We do not know the quantified health and mission outcomes due to medical events during exploration missions.
- 2.02 – We do not know how the inclusion of a physician crew medical officer quantitatively impacts clinical outcomes during exploration missions.
- 3.01 - We do not know the optimal training methods for in-flight medical conditions identified on the Exploration Medical Condition List taking into account the crew medical officer’s clinical background. (Closed)
- 3.03 - We do not know which emerging technologies are suitable for in-flight screening, diagnosis, and treatment during exploration missions.
- 4.02 - We do not have the capability to provide non-invasive medical imaging during exploration missions.
- 4.08 - We do not have the capability to optimally treat musculoskeletal injuries during exploration missions.
- 4.14 - We do not have the capability to track medical inventory in a manner that integrates securely with the medical system during exploration missions.
- 4.15 - Lack of medication usage tracking system that includes automatic time stamping and crew identification
- 4.17 - We do not have the capability to package medications to preserve stability and shelf-life during exploration missions.
- 4.24 - Lack of knowledge regarding the treatment of conditions on the Space Medicine Exploration Medical Condition List in remote, resource poor environments (Closed)
- 5.01 - We do not have the capability to comprehensively manage medical data during exploration missions.

Other Pertinent Documents

List of Acronyms

A	
ACE™	All Cotton Elastic
B	
BZK	Benzalkonium antiseptic
C	
CMO	Crew Medical Officer
CT	Computed Tomography
D	
DRM	Design Reference Mission
E	
EMCL	Exploration Medical Condition List
EVA	Extravehicular Activity
H	
HRP	Human Research Program
I	

ISS	International Space Station
M	
MB	Megabyte
MRI	Magnetic Resonance Imaging
N	
NASA	National Aeronautics and Space Administration
NEA	Near Earth Asteroid
S	
SAM®	Structural Aluminum Malleable
U	
U.S.	United States

References

1. Scheuring RA, Mathers CH, Jones JA, Wear ML. Musculoskeletal injuries and minor trauma in space: incidence and injury mechanisms in U.S. astronauts. Aviat Space Environ Med 2009 Feb;80(2):117-24.
2. Marshburn TH. Acute Care. In: Barratt M, Pool S, editors. Principles of Clinical Medicine for Space Flight. New York: Springer; 2008. p. 101-22. (Marshburn, 2008).

Last Update

This topic was last updated on 8/12/2014 (Version 2).

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